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UNITED STATES DEPARTMENT OF AGRICULTURE • Economic Research Service

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Agricultural Economics Research

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The Mechanics of Agricultural Productivity and Economic Growth

By Raymond P. Christensen and Harold T. Yee

Increases in agricultural productivity contribute to national economic development and income growth in two major ways: they release labor resources for nonagricultural sectors and they supply an economic output above that consumed or used for further production in the agricultural sector—an "economic surplus" that can be transferred out of agriculture to provide capital for economic growth in the nonagricultural sectors. This paper suggests ways of measuring changes in agricultural output, input, and productivity and the contribution that increases in agricultural productivity can make to national income growth. Like Singer's article, it deals with mechanical aspects of economic growth.[1] It suggests an analytical framework for research on conditions influencing improvement in agricultural productivity.

HYPOTHETICA is an imaginary country, invented to illustrate the thesis of this paper. It is unique with respect to data available for analysis. It is a developing country with structural characteristics similar to many in the "real world." However, economic progress in improving agricultural productivity and national income in Hypothetica during the last two decades should not be considered typical for all low-income countries. Some in this group have had little if any growth as measured by rise in per capita income.

Agricultural Output

Agriculture in Hypothetica is shifting gradually from subsistence to commercial production. Half of the products produced in 1960 were marketed as compared with less than 40 percent in 1940.

Part I of table 1 shows that total agricultural output doubled from 1940 to 1960. All value data are in 1957–59 prices.

[1] W. H. Singer, "The Mechanics of Economic Development," *Indian Econ. Rev.*, August 1952.

TABLE 1.—*Agricultural output, input, and productivity in Hypothetica, 1940 and 1960, and percentage change*

Item	1940	1960	Percentage change
	Million dollars	*Million dollars*	
I. Agricultural output, total	10, 000	20, 000	100
A. Products, total	8, 000	16, 000	100
1. Subsistence	5, 000	8, 000	60
2. Marketed	3, 000	8, 000	167
a. Domestic	2, 000	5, 500	175
b. Export	1, 000	2, 500	150
B. Capital improvements, total	2, 000	4, 000	100
1. Land clearing, drainage, etc	1, 500	3, 000	100
2. Livestock and draft animals	500	1, 000	100
II. Agricultural input, total	9, 000	15, 000	67
A. Inputs from within agriculture, total	7, 000	11, 000	57
1. Land	4, 000	6, 250	56
2. Land improvements	1, 000	1, 500	50
3. Working capital (seed, livestock, etc.)	500	1, 000	100
4. Labor of rural people	1, 500	2, 250	50
B. Inputs from outside agriculture, total	2, 000	4, 000	100
1. Fixed capital improvements	500	1, 500	200
2. Working capital (fertilizer, etc.)	1, 500	2, 500	67
III. Net agricultural output, total output less inputs from outside agriculture	8, 000	16, 000	100
IV. Productivity measures:			
A. Total agricultural output per unit of total input	*Dollars* 1. 11	*Dollars* 1. 33	20
B. Net agricultural output per unit of input from within agriculture	1. 14	1. 45	27
C. Agricultural products per acre	80	100	25
D. Agricultural products per worker	286	381	33
V. Land and labor inputs:	*Number*	*Number*	
A. Land, million acres	100	160	60
B. Agricultural workers, million	28	42	50

It is customary to include only products in measures of agricultural output. Such measures are meaningful. But land has been cleared, drained,

and irrigated, and farm buildings have been constructed in Hypothetica. The total acreage under cultivation has gone up 60 percent. Resources employed in agriculture, especially labor used to make farm improvements, have added to the capital stock of the country. Therefore, net additions to fixed capital are included in the total agricultural output of Hypothetica.

Products are "end products"—those available for domestic consumption, for export, or for adding to farm stocks. Crops fed to livestock are included in livestock products, so there is no double counting.

Obviously, most countries do not have data for measuring agricultural output precisely in all the above categories, but it is necessary to be aware of them and to know at least approximately the relative importance of each.

Subsistence products are valued at farm prices of marketed products. In the case of capital items, data refer to the annual value of their services.

Agricultural Input

Part II of table 1 shows that agricultural input increased 67 percent from 1940 to 1960. For land and capital goods, inputs refer to the value of annual services at 1957–59 prices. This also is true of labor.

Again, it may be noted that agriculture in Hypothetica is chiefly subsistence. A small, but slowly increasing, proportion of the input used annually is from nonagricultural sectors.

Even in Hypothetica where detailed data are available, it is difficult to decide on the appropriate values to place on inputs from within agriculture (land, fixed capital improvements on land, and labor) because there are few market sales of these inputs. We will return to problems of valuing inputs and outputs later.

Agricultural Productivity

Part III of table 1 indicates change in net agricultural output (agricultural sector output) from 1940 to 1960 with respect to the rest of the economy. Total agricultural output less inputs from other sectors is agriculture's contribution to the total economy. For illustrative purposes, we define this as gross national product (GNP). This definition of GNP, of course, differs from the usual one used in national accounts. Hypothetica's GNP from agriculture, or agricultural sector output, doubled from 1940 to 1960.

Part IV of table 1 shows changes in agricultural productivity. Total agricultural output per unit of total input increased 20 percent. But net agricultural output per unit of input from within agriculture increased 27 percent.

Most of the expansion in agricultural output resulted from the use of more inputs, mainly from within agriculture (labor, land, and capital improvements). Capital inputs purchased from nonagricultural sectors have become relatively more important. They have facilitated the application of new technology for increased agricultural output per worker and per acre.

Land area in agriculture increased 60 percent. Despite extension of the cultivated area to poorer lands, agricultural products per acre increased by a fourth. Labor input increased 50 percent. Agricultural products per worker increased a third.

Table 2 shows changes in the "input mix" associated with increased productivity. Land, including land improvements, is the major input. It accounted for over half of total input in 1960 as well as in 1940. Labor is a relatively minor input measured in value terms, a reflection of the abundance of labor relative to other input items. Capital has increased its importance.

Land and labor in agriculture have very low values in alternative uses. It is of interest to observe the additional returns from the additional nonagricultural inputs. If it can be assumed that the additional land and labor used were "costless," then the increased capital input of $2 billion was

TABLE 2.—*Percentage distribution of inputs, Hypothetica, 1940 and 1960, and percentage change in value of inputs*

Input categories	Items from table 1	Percentage distribution		Percentage change, 1940 to 1960
		1940	1960	
Land and land improvements	II-A-1, II-A-2	55	52	55
Labor	II-A-4	17	15	50
Capital	II-A-3, II-B	28	33	100
Total		100	100	67

associated with increased output of $10 billion, or a ratio of 1 to 5.

Subsistence and Market Sectors

Subsistence and market sectors of agriculture need to be considered separately (table 3). The market sector, of course, is the source of economic surpluses that can be transferred from agriculture to other sectors.

In 1940, value of agricultural products marketed exceeded value of purchased input by $1 billion. This $1 billion, plus output retained in agriculture and value at $7 billion, meant that agriculture's contribution to the GNP was $8 billion. Agriculture supplied food and other products for consumption in nonagricultural sectors. In addition, it was an important earner of foreign exchange as the value of agricultural exports was much larger than that of agricultural imports.

In 1960, total agricultural output exceeded total input by $5 billion, $4 billion more than in 1940. Hypothetica has an effective taxation program for capturing a substantial part of the increased product resulting from increased agricultural productivity, and a development program for using it in nonagricultural sectors. Of the increase in the economic surplus, $3 billion was retained in the agricultural sector. The remaining $1 billion was taxed away from agriculture.

Transfer of agricultural income into nonagricultural sectors can, of course, take place in other ways:

1. Real prices of food and other agricultural products may decline. This indirectly reduces production costs in industry and other sectors where wage rates are influenced by food costs.

2. Landlords and others who share in agricultural income may transfer some of this income into nonagricultural uses by making investments in industry.

3. Agricultural people who move into nonagricultural sectors may "take along" or transfer money from agriculture to other sectors. Agriculture, of course, pays costs of rearing, educating, and training people who migrate to urban areas.

TABLE 3.—*Value of agricultural output and input by sectors, Hypothetica, 1940 and 1960, and percentage change*

Sector	Items from table 1	1940	1960	Percentage increase
		Million dollars	*Million dollars*	
MARKET				
Agricultural products.	I–A–2	3, 000	8, 000	167
Purchased inputs	II–B	2, 000	4, 000	100
Difference		1, 000	4, 000	300
SUBSISTENCE				
Agricultural output	I–A–1, I–B.	7, 000	12, 000	71
Inputs	II–A	7, 000	11, 000	57
Difference			1, 000	
TOTAL				
Agricultural output	I	10, 000	20, 000	100
Agricultural input	II	9, 000	15, 000	67
Difference		1, 000	5, 000	400

TABLE 4.—*Total agricultural production, per capita consumption, and population, Hypothetica, 1940 and 1960*

Items	1940	1960	Percentage increase
Total production million dollars	8, 000	16, 000	100
Exports do	1, 000	2, 500	150
Difference do	7, 000	13, 500	93
Imports do	500	1, 500	200
Total available for domestic use do	7, 500	15, 000	100
Per capita consumption dollars	75	91	21
Total population million	100	165	65

Markets and Consumption Levels

Market demand for agricultural products has increased rapidly with population growth and higher per capita incomes, especially in urban areas. Although total agricultural output has increased at a compound annual rate of 3.5 percent a year, it has been necessary to increase imports of food in order to meet increased economic demand and keep the cost of living stable. Per capita consumption of agricultural products has gone up 21 percent, about 0.8 percent a year (table 4).

The growth rate in total demand for agricultural products is equal to population growth rate (p), plus growth rate for per capita income (g) times income elasticity of demand (n). The population growth rate for Hypothetica has been relatively rapid, about 2.6 percent a year. Per capita income has increased at about 1.3 percent a year. Income elasticity of demand for agricultural products is relatively high, approximately 0.8. By substituting appropriate numbers in the equation, $D=p+gn$, it can be observed that total demand for agricultural products increased at a rate of 3.64 percent a year. Domestic demand for agricultural products has increased a little more rapidly than agricultural production.

Larger agricultural imports have been financed by food aid programs. Hypothetica has had difficulty earning enough foreign exchange to finance imports of capital goods required for industrial development. If it had not been for food aid programs, industrial growth would have been retarded, more people would have remained in agriculture, and national income growth would have been slower.

National Income Growth

As in other developing countries, and in developed countries too, per capita incomes in Hypothetica average much lower in agriculture than in nonagricultural sectors (table 5).

Two things need to be noted with regard to the above data: (1) $1 billion of the increase in net product of agriculture was transferred to nonagricultural sectors; (2) the large percentage rise in per capita income for the total population resulted partly from transfer of people from agriculture, where incomes are low, to nonagricultural sectors where they are higher.

The gain in agricultural productivity was large enough to cause incomes per person to rise by about as large a percentage in agriculture as in other sectors, even though a part of the gain was transferred to nonagricultural sectors.

A large part of total output (GNP) was used for capital investment or new development, one-fourth in 1940 and 26 percent in 1960. These large investments have helped make possible a high national output growth rate, about 4.5 percent a year.

In 1940, one-half of total capital investment originated from output in the agricultural sector.

TABLE 5.—*Gross national product, capital investment, and income, total and per capita, Hypothetica, 1940 and 1960*

Item	1940	1960	Percentage increase
Agricultural sector:			
GNP from agriculture million dollars	8, 000	16, 000	100
Capital investment do	2, 000	4, 000	100
Net income for consumption do	6, 000	12, 000	100
Net income per person dollars	86	114	33
Population million	70	105	50
Nonagricultural sectors:			
GNP from rest of economy million dollars	8, 000	22, 200	177
Capital investment do	2, 000	6, 000	200
Net income for consumption do	6, 000	16, 200	170
Net income per person dollars	200	270	35
Population million	30	60	100
Total economy:			
GNP million dollars	16, 000	38, 200	139
Capital investment do	4, 000	10, 000	150
Net income for consumption do	12, 000	28, 200	135
Net income per person dollars	120	171	42
Population million	100	165	65

In 1960 the agricultural sector's contribution to total investment decreased to 40 percent. Growth in national income, of course, resulted from increased productivity in other sectors as well as from increased productivity in agriculture.

Transfer of Labor Resources

In terms of employment, Hypothetica was chiefly an agricultural country in 1940 and continued to be so in 1960, although there was a large net migration from agriculture to other sectors (table 6).

The population growth rate was 2.6 percent per year for the country as a whole. Population in nonagricultural sectors doubled while that in agriculture increased by one-half. Agriculture accounted for 64 percent of total population in 1960 as compared with 70 percent in 1940. Population and employment in nonagricultural sectors in-

TABLE 6.—*Distribution of total population by employment sectors, Hypothetica, 1940 and 1960*

Sector	1940	1960			
		With migration to nonfarm sectors		With no migration	
	Million persons	*Million persons*	*Percent*	*Million persons*	*Percent*
Agriculture	70	105	64	115.5	70
Nonagriculture	30	60	36	49.5	30
Total	100	165	100	165.0	100

creased 3.5 percent a year while that in agriculture increased about 2.1 percent a year. We assume that 40 percent of the total population in both periods constitutes the work force. Had we not assumed a constant age distribution for both periods, the population and employment growth rates would have differed.

Net movement of people from agriculture to other sectors during the 1940–60 period (10.5 million) was equivalent to 15 percent of the total population in agriculture in 1940, or to about 10 percent of the total population. About 18 percent of the labor force in nonagricultural sectors in 1960 were people who moved out of agriculture during the 1940–60 period.

The contribution of agriculture to the labor force in nonagricultural sectors was large. But movement of people out of agriculture would have been even larger if employment opportunities in the other sectors had increased at a faster rate. Income levels in nonagricultural sectors average much higher than those in agriculture. However, Hypothetica has done well to increase employment in nonagricultural sectors by 3.5 percent a year.

In most developing countries population growth rates are higher in agriculture than in other sectors. If the population growth rate for agriculture had been higher and that for other sectors had been lower in Hypothetica, a much larger net migration out of agriculture would have been necessary to achieve the 100 percent growth in nonagricultural population and the 50 percent growth in agricultural population.

Investments made by rural people to improve their education and skills, of course, are transferred out of agriculture when they move to nonagricultural sectors. But even more important is the fact that agriculture pays the costs of rearing rural people who move from rural to urban areas. As suggested by Kuznets,[2] if it is assumed that the cost of rearing, educating, and training rural people is equal to the income received per person in the agricultural sector over a 10-year period (about $950 per person), net migration of 10.5 million people from agriculture to other sectors represents transfer of investment in the "human agent" of about $10 billion from agriculture to other sectors during the 1940–60 period.

Valuation Problems

Economists are faced with difficult problems in measuring agricultural output, input, and productivity in Hypothetica because of the subsistence nature of agriculture.

A reasonably good job in valuing agricultural products can be done if substantial quantities move to markets that establish prices for them. However, market-pricemaking forces operate imperfectly in Hypothetica.

Values placed upon inputs of land and fixed capital improvements (and outputs in the form of land improvements) are based on prices established by relatively few market transactions. These prices, too, are influenced by imperfect markets. An additional problem is that of deciding how to value the annual service of land and other fixed investments. Obviously, it is necessary to assume a capitalization or interest rate. Interest rates also are likely to be influenced by imperfect market conditions, with many buyers and few sellers.

Finally, there is the question of how to value labor input when most agricultural workers are self-employed. It is usual to impute values for labor of the self-employed chiefly on the basis of wage rates of hired workers.

Do these difficulties in placing values on inputs and outputs in agriculture mean that estimating changes in agricultural output, input, and productivity is a meaningless exercise? The answer, of course, is *no*. By going through this exercise,

[2] Simon Kuznets, "Economic Growth and the Contribution of Agriculture: Notes on Measurement," *Internatl. Jour. Agrar. Affairs*, vol. 3, pp. 59–75, 1961.

country by country, much can be learned about the magnitudes of the variables affecting agricultural output and productivity, the obstacles to economic progress in agriculture, and the role of agriculture in national economic growth.

The values placed on inputs from within agriculture are imputed values, and these influence estimates of the relative importance of land, labor, and capital in the "input mix." Labor, for example, may account for a small part of total input in less developed countries because it has a low value per unit. The reverse is true of capital. Thus, agriculture in less developed countries uses large quantities of labor and small quantities of capital as compared with agriculture in the highly developed countries.

There appears to be no escape from the general conclusion that the physical volume of capital must increase relative to that of labor in order to improve agricultural productivity. However, if additional capital is to be most effective, it must be in the forms and combinations required for the application of improved technology.

Conditions Influencing Productivity

It is difficult to develop precise measures of change in agricultural productivity and the contributions that such gains make to national economic growth. But these tasks are simple, compared with measurement of the conditions that cause gains in agricultural productivity.

The sources or "proximate causes" of increased agricultural output are apparent. For example, agricultural output depends upon the level of technology and quantities of land, labor, and capital inputs. In Hypothetica the volume of conventional inputs (land, labor, and capital) increased 67 percent, but output per unit of input (technology) increased 20 percent. However, the combination of inputs was changed with the input of additional capital goods. A substantial part of the additional output might be attributed to change in the input mix and new or improved inputs.

Perhaps the most effective way to analyze the factors affecting agricultural output and productivity is to consider them in the traditional supply and demand framework. On the supply side the following need to be considered:

1. Traditions and attitudes affecting farming methods and practices. Can people be induced by economic incentives to change customs and practices?

2. Available technology. Do farmers have access to combinations of improved practices or production techniques which are adapted for soil and climatic conditions?

3. Diffusion of knowledge about improved technology. Farmers obviously need to know about improved production practices if they are to adopt them.

4. Supplies of additional inputs, including land, labor, and capital. Most improved production methods, even better seeds, require additional capital inputs. Are these available, and if so, at what price?

5. Tenure, credit, taxation, and marketing systems, with reference to how they influence production and marketing costs.

On the demand side, the following merit attention:

1. Population and income growth in nonagricultural sectors that causes demand for farm products to increase and to change in composition.

2. Export markets for agricultural products. These may expand less than domestic markets, depending upon the product.

3. Increases in subsistence demand resulting from farm population growth.

4. Tenure, credit, taxation, and marketing systems, with regard to how they affect prices received by farmers and the quantities of products that can be sold at these prices.

5. Transportation, storage, and processing facilities that influence demand and prices of farm products at the farm level.

In Conclusion

First, factors that affect supply and demand for agricultural products are interrelated and often cannot be classified neatly in either the demand or supply category. For example, improvement in prices and expansion in demand for farm products may cause farm people to conserve soil and water resources, which in turn will lead to lower

unit costs of production and add to the supply of agricultural inputs.

Second, the distinction between additional output resulting from higher levels of productivity and additional output resulting from the use of additional inputs is important. If agriculture is to contribute to economic growth, it must become more productive as measured by output per unit of input. Raising agricultural output by employing more inputs from the nonagricultural sectors is not sufficient.

Third, changes in the input mix and a larger output usually are associated with increased productivity. In Hypothetica, agricultural output increased 5 percent on the average for each 1 percent increase in total output per unit of total input. The experience of the United States has been similar. In Hypothetica, demand for agricultural products kept pace with increase in supply. Increased output and productivity did not depress prices of products. But this will not always be true for developing countries.

Finally, economic progress in agriculture and in other sectors is interdependent. There is nothing magic about productivity gains in agriculture. Gains in nonagricultural sectors are equally important. In Hypothetica, nonagricultural sectors helped improve agricultural productivity by making available larger supplies of fertilizer, tools, and machines, and by providing employment opportunities for rural people. Growth in domestic and foreign markets made expansion in agricultural output profitable and thereby contributed to gains in agricultural productivity.

Effects of Price Specials on Volume of Sales of Frying Chickens

By Leo R. Gray

Every week, major food retailers have advertisements in local newspapers in which they feature commodities at special sale prices. Probes to measure the effects of advertising these price specials, however, are relatively recent in marketing economics research. What effect do retail price specials have on total sales in a market area, or in the whole Nation? A preliminary study that attempted an aggregate approach to this problem for frying chickens was published by the USDA in 1963.[1] A substantial increase in sales volume would be expected when fryers are featured as a special. Such a change in volume should exceed the normal increase expected from just lowering the price without featuring the item. As a result, the demand function at a designated price level during a special sales promotion should shift to the right—larger sales at the same price. The interaction of price and special sales advertising might also be expected to change the slope of the demand function in a direction that would indicate an increase in price elasticity of demand. These changes would occur if consumers spent a greater percentage of their incomes on fryers in sale weeks than in nonsale weeks.

THIS PAPER is concerned primarily with the development of an analytical framework designed to measure the effect of price specials and advertising on the volume of sales of frying chickens.[2] Accordingly, it presents an analytical model built around selected variables influencing demand. Coefficients for the variables were estimated mathematically and tested statistically to provide a measure of the forces influencing demand, and of shifts in demand associated with special sales promotion.

An empirical analysis, made by the method presented here, indicated that price elasticity of demand for frying chickens in the Washington, D.C., metropolitan area was around -1.75 in nonsale weeks. Special sales promotion resulted in a significant shift in the demand function during the sale weeks. But the analysis shows this shift to be largely parallel, with little change in slope.

Data and Variables

The major economic factors that influence the volume of sales in a given market area include the price of chicken, volume sold in the previous week, advertising, the price and volume of competing products, population, seasonal variation, and possibly other factors. The data available for this study include weekly volume of sales and prices of poultry in the Washington, D.C., metropolitan area. Aggregate estimates for the market area are based on a representative sample of firms for each week in 1960 and 1961. No information was collected on the volume and price of competing meats such as beef, pork, and other poultry. Population was assumed to be essentially unchanged for the specified market area. The following variables are included in the analytical model:

V_t=Weekly volume of estimated sales by all retailers in the market area.

v_t=Deviation from the average of weekly volumes for corresponding weeks of each year.

P_t=Weekly price, a weighted average of estimated selling prices of all retailers each week in the market area.

p_t=Deviation from the average of weekly prices for corresponding weeks of each year.

V_{t-1}=Weekly volume of estimated sales by all retailers in the market area in the previous week.

v_{t-1}=Deviation from the average of lagged weekly volumes for corresponding weeks of each year.

D_t=A dummy shift variable used to differentiate between a sale week and nonsale week. A week was classified as a "sale week" if four or more firms advertised frying chickens in selected newspapers. The sale week

[1] Leo R. Gray, "Retail Price Specials for Frying Chickens in Selected U.S. Cities," U.S. Dept. Agr., Econ. Res. Serv., ERS–101, January 1963, 24 pp.

[2] The author is grateful to Dr. James E. Martin, of the Department of Agricultural Economics, University of Maryland, for his guidance in the development of this paper.

was given a value of 1, the nonsale week zero.

SD_t=The dummy slope variable, which is the product of the price each week times the dummy shift variable (D_{1t}) for that week. For the dummy slope variable, the sale week was given a value of +1, and the nonsale week a value of −1. If the coefficient of the slope variable is significant, the slope of the demand curve for the sale week has changed significantly and will intersect rather than parallel the demand curve in the nonsale week. Otherwise there is no evidence that the slopes of the demand curves for sale and nonsale weeks are different.

In order to reduce the effect of seasonal variations during the year, variables for sales volume (V_t and V_{t-1}) and price (P_t) are represented in the analytical framework as deviations of the weekly volume and price from the average for the corresponding 2 weeks in 1960 and 1961. For example, the price variable for the first full week of June 1960 is the deviation of this weekly price from the average for the first full week in June 1960 and June 1961. The shift and slope variables used are as described above.

The Estimating Model

Weekly deviations in sales volume as described above were expressed as a function of the deviations in the weekly price, and in sales the preceding week, the dummy shift variable reflecting the "sale" and "nonsale" weeks, and the dummy slope variable. The functional relationship is expressed as follows:

$$V_t = a_0 + b_1 p_t + b_2 v_{t-1} + b_3 D_t + b_4 SD_t + u_t \quad (1)$$

Empirical estimates for the demand function specified in equation (1) were estimated by the least squares technique. Prices and volumes for firms advertising specials are aggregated with those for firms not featuring fryers, in order to arrive at a market area concept. In addition to the usual assumptions relating to least squares estimates, this aggregate approach also assumes that: (1) The model allows for consumers who shift their purchases from one store to another because of specials advertised in newspapers; (2) the lagged response of consumers to price changes is at least partially overcome by using aggregate data for 103 consecutive weekly observations; (3) the number of customers served includes all who purchased chickens in retail stores in the market area in 1960–61; and (4) the average price of whole fryers for the total market area would fall between the advertised and nonadvertised prices. Price data used in this study are for whole fryers, but the total volume of sales includes all forms of fryers sold. Prices of cutup fryers and parts are not included, because they are assumed to be based on and to follow closely the prices of whole fryers. The predictive equation estimated from the above model, showing the coefficients and tests of statistical significance ("t" values), is as follows:

$$\begin{aligned} v_t = &-73.937 - 55.391 p_t - 0.340 v_{t-1} \\ &\quad (-7.062)\ (-4.645) \\ &+ 146.382 D_t - 5.307 D_{1t} p_t \quad (2) \\ &\quad (2.830)\ (-0.676) \end{aligned}$$

The expected coefficient of determination (R^2) is equal to 0.483; the analysis of variance (F^5_{98}) is equal to 18.316; the "t" test values, with 98 degrees of freedom, are indicated by the numbers in parentheses under their respective coefficients.

Interpretation of Results

The general nature of the demand responses for the nonsale and the sale weeks, based on the above analysis, is illustrated in figure 1. Figure 1 was constructed by varying price (P_t) and holding all other variables in equation (1) at their 103-week mean values. This figure shows the demand shift associated with special sales promotion and price changes. For example, at a price of 33 cents per pound, the volume of sales in the special sale weeks averaged about 14 percent above the average for the nonsale weeks. The analysis suggests that the price of chicken was the major factor influencing the volume of sales. The price elasticity of demand was −1.75 as computed from the price coefficient in equation (2), with prices and volumes held at their means. This suggests that a 10 percent reduction in the price of chicken tended to step up consumption by around 17 or 18 percent (table 1).

The analysis also indicated that sales in the preceding week, though less important than price, were significantly related to the volume of sales in the current week. This influence was negative; when sales last week were 10 percent above

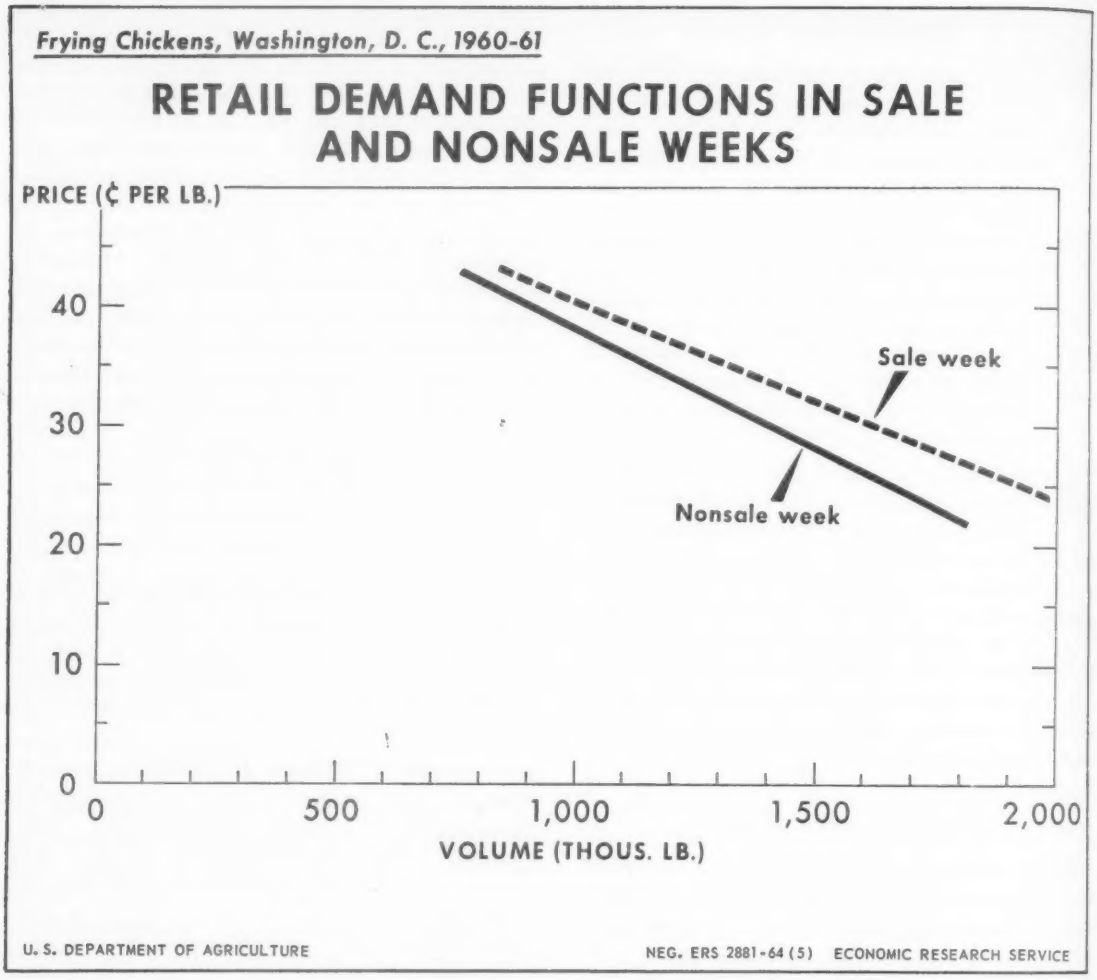

FIGURE 1

average, sales in the current week were reduced about 3½ percent. The expected coefficient (b_3) on the dummy shift variable (D_t) is positive and large, but its standard error is also large. Nevertheless, the "t" test shows that there was a significant shift to the right in the demand function from the nonsale to a sale week in response to special sales promotion. Since prices were usually reduced along with special sales advertising, the shift in the demand function reflects a sort of composite of the influence of both price and special promotion.

The expected coefficient (b_4) on the dummy slope variable (SD_t) is insignificant. Accordingly, it appears that the slope of the demand function in the special sale weeks was not significantly different from that in the nonsale week. This shift, with only a slight change in slope, also suggests little change in price elasticity of demand between the sale and the nonsale weeks.

Figure 2 shows estimates of the observed and expected weekly volumes of frying chickens sold by all retailers in the Washington, D.C., area in 1960–61. The expected volumes were computed using equation (3):

$$V_{tt}=-73.937+K_t-55.391(P_{tt})-0.340(V_{tt-1}) +146.382(D_{tt})-5.307(D_{1tt}P_{tt}) \quad (3)$$

where K_t is the changing correction factor added

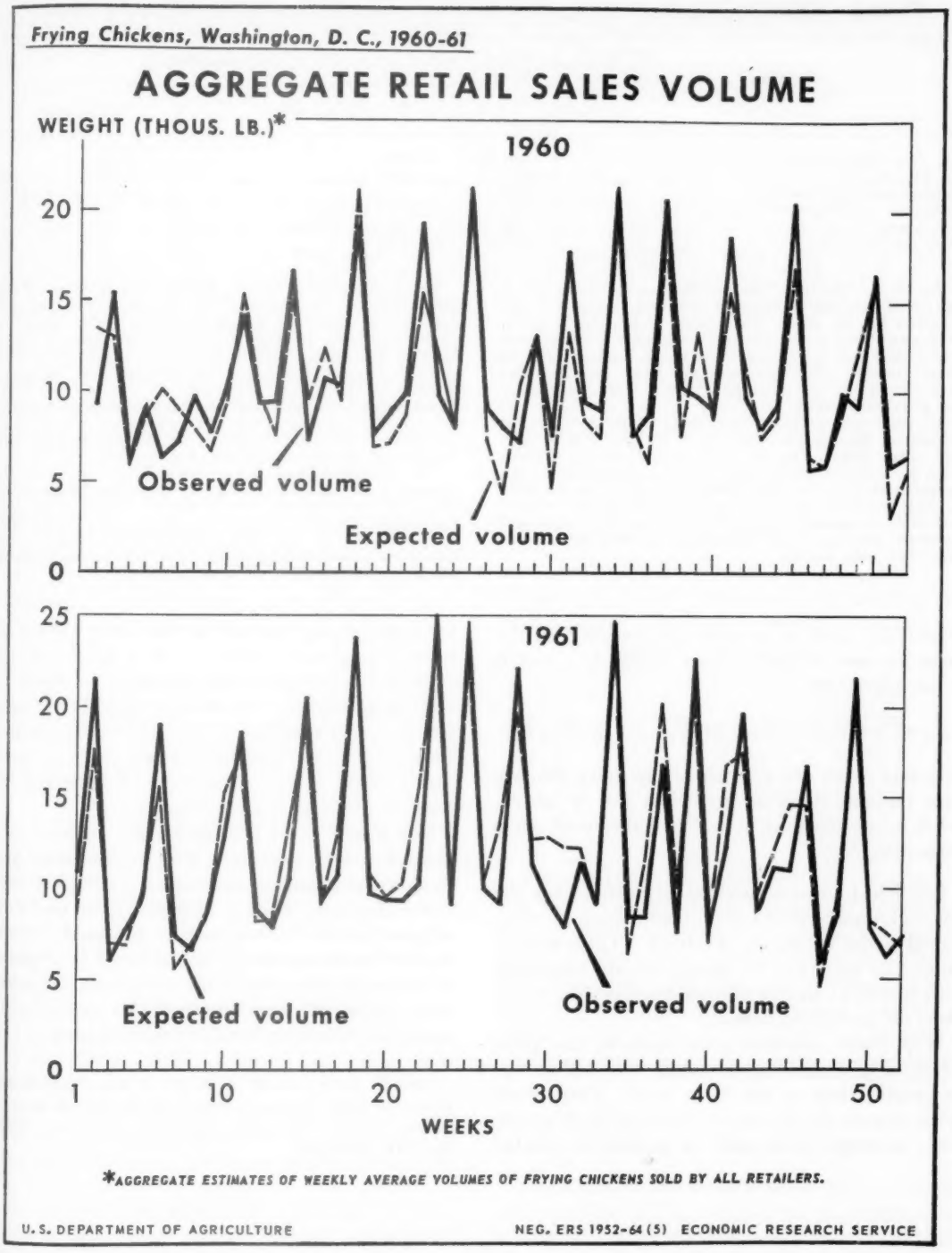
Frying Chickens, Washington, D. C., 1960-61
AGGREGATE RETAIL SALES VOLUME
WEIGHT (THOUS. LB.)*
1960
20
15
10
5
0
Observed volume
Expected volume
25
20
15
10
5
0
1961
Expected volume
Observed volume
1
10
20
30
40
50
WEEKS
*AGGREGATE ESTIMATES OF WEEKLY AVERAGE VOLUMES OF FRYING CHICKENS SOLD BY ALL RETAILERS.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 1952-64 (5) ECONOMIC RESEARCH SERVICE

FIGURE 2

TABLE 1.—*Estimates of price elasticity of demand for frying chickens, this study and 5 others*

Study	Years	Price elasticity	
		Nonsale week	Sale week
L. R. Gray (this study)	1960–61	−1.7473	−1.9108.
J. E. Martin [1]	1952–58	−1.7653	−1.9952.
Saunders and Stoddard [2]	1959		−1.79 and −3.84.
Nordhauser and Farris [3]	1958	−1.80	
B. F. Stanton [4]	1953–59	−1.534 and −1.324	
Hilner and Smith [5]	1959–60	−2.6728	

[1] James E. Martin, "An Application of Distributed Lags in Short-Run Consumer Demand Analysis," unpublished Ph. D. thesis, Iowa State Univ., Ames, 1962. The nonsale week represents static elasticity for 4 13-week periods; the sale week represents static elasticity for 13 4-week periods. The estimates are based on Michigan State University consumer panel data, collected weekly over a 7-year period.

[2] R. Saunders and E. Stoddard, "Effects of Fryer Specials on Supermarket Sales and Profits," Maine Agr. Expt. Sta. Misc. Pub. 643, 14 pp., September 1960. These are arc elasticities based on per capita data from 7 supermarkets in central Maine for 16 weeks in 1959. The first elasticity shown represents changes in 4 supermarkets from nonsale to low-margin sale weeks; the second represents changes in 3 supermarkets from nonsale to below-cost sale weeks.

[3] F. Nordhauser and P. L. Farris, "An Estimate of the Short-Run Price Elasticity of Demand for Fryers," *Jour. Farm Econ.*, vol. 41, pp. 798–803, 1959. This is a pooled elasticity estimate based on data from 6 supermarkets in Indiana for 23 weeks.

[4] B. F. Stanton, "Seasonal Demand for Beef, Pork, and Broilers," *Agr. Econ. Res.*, vol. 13, No. 1, pp. 1–14, January 1961. Elasticities are based on quarterly data for per capita consumption and deflated retail prices in the United States for 7 years. The first elasticity shown was for winter, the second was for summer.

[5] H. R. Hilner and R. C. Smith, "An Experimental Approach to the Estimation of the Short-Run Price Elasticity of Demand for Broilers," Univ. Del. Agr. Expt. Sta. Bul. 344 (Technical), 15 pp., November 1962. This elasticity is constant throughout the range of the demand curve, and is based on data from 5 supermarkets for 11-week periods in 1959 and in 1960.

in each ith week to account for the effect of the mean for each variable. Specifically, K_i is equal to the following:

$$K_i = \overline{V_{it}} + 55.391\overline{P_{it}} + 0.340\overline{V_{it-1}} + 5.307D_{1it}\overline{P_{it}}$$

(If a sale week, the product of the mean dummy slope variable times its coefficient will be added, but if a nonsale week it will be subtracted when computing K_i.)

Empirical price elasticities of demand for the sale and nonsale weeks as estimated from the analytical model are shown in table 1. These results, insofar as they can be compared, are consistent with results of similar studies conducted in recent years but in different areas.

With fixed absolute price spreads, the price elasticity of demand at the retail level will always be greater than at the farm level. Farm-retail price spreads for frying chickens in Washington, D.C., averaged 15.8 cents a pound in selected monthly pricing periods for 1960–61.[6] If we assume this average spread to be a fixed absolute amount for nonsale weeks, elasticity at the farm level then becomes −0.9883, or slightly inelastic for fryers in nonsale weeks. During periods of special sales promotions, however, the demand curve would shift to the right and thereby become more elastic at all market levels.

The above analytical model can be used as a tool for management in making week-to-week predictions and policy decisions. Aggregate estimates for regional or national data could be adapted for use in this model. It would perhaps be feasible to expand the model based on regional or national estimates, since such data on prices and volumes of competing meats are more readily available than data for metropolitan areas.

[6] Leo R. Gray and R. J. Willis, "Price Spreads and Prices for Eggs, Frying Chickens, and Turkeys in Selected Cities, 1956–61," U.S. Dept. Agr., Econ. Res. Serv., ERS-60, p. 11, April 1962.

Projection of Farm Numbers for North Dakota With Markov Chains

By Ronald D. Krenz

The Markov process was first applied in economics to problems of relative structure, as for example in the analysis of income and wage distributions. The extension of such distributions over time was an initial step in projection. The analysis in this paper takes a further step by developing a method for making projections of absolute numbers from an appropriately modified Markov base. This new departure represents both a weakness and a strength; weakness because the modifying assumptions abstract considerably from reality, but strength because the technique covers a broader area of obvious need.

THE RESULTS of the 1959 Census of Agriculture have given rise to much speculation regarding the future number of farms. Current literature contains numerous analyses of census data and discussions of the implications for agricultural policy and farm-income problems (*3*, *6*, *7*, and *10*).[1]

The article reports the use of the Markov-chain process to project future farm numbers in North Dakota from census data. Such projections are useful in studies of economic adjustments and area development.

Concept of Markov Chains

The concept of Markov chains was introduced around 1907, but did not come into general use by economists until fairly recently. In the last few years the technique has seen considerable use in the analysis of income and wage distributions (*9*) and in studies of the size distributions of firms in the steel industry (*1*). In the field of agriculture it has been used to study sizes of hog-producing firms (*5*) and farm tenure in Illinois (*8*) and wheat yields in Montana (*2*).

For those who are not familiar with Markov chains, the study of wheat yields in Montana by Bostwick (*2*) gives a good general explanation of the technique.

The process assumes that any population of firms or individuals can be classified into various groups or "states" and that movements of firms or individuals between states over time can be regarded as a stochastic process. With a given set of states (S_1, S_2 . . . S_n), it is assumed possible to estimate the probabilities (p_{ij}) of firms moving from S_i to S_j. These probabilities of movements during a given time period can be expressed in a transition matrix P:

$$P = \begin{array}{c} \\ S_1 \\ S_2 \\ \cdot \\ S_n \end{array} \begin{array}{c} \begin{array}{cccccc} S_1 & S_2 & . & . & . & S_n \end{array} \\ \begin{bmatrix} p_{11} & p_{12} & . & . & . & p_{1n} \\ p_{21} & p_{22} & . & . & . & p_{2n} \\ . & . & . & . & . & . \\ p_{n1} & p_{n2} & . & . & . & p_{nn} \end{bmatrix} \end{array} \quad (1)$$

The states used in this analysis are the size groups used by the U.S. Census Bureau classification of farms, as follows:

State	*Farm size (acres)*
S_0	No farms.
S_1	10–99.
S_2	100–179.
S_3	180–259.
S_4	260–499.
S_5	500–999.
S_6	1,000 and over.

Various types of projections can be obtained from the transition matrix and the initial distribution of farms. Among other items, this method will give estimates of the equilibrium distribution and number of farms, the mean lifetime of a farm within a size state, and indexes of mobility of farms among states. Our principal concern is with projections of farm numbers at various future dates.

Estimating a Transition Matrix

To estimate a transition matrix, data are needed that describe the movements of individual firms over time. With such data the transition probabilities can be estimated by averaging these movements. However, in the problem at hand, and for

[1] Italic numbers refer to Literature Cited, p. 83.

TABLE 1.—*Farm numbers in North Dakota, 1935–59*

Year	Size state						Total
	S_1	S_2	S_3	S_4	S_5	S_6	
	Farms	*Farms*	*Farms*	*Farms*	*Farms*	*Farms*	*Farms*
1935	3, 948	13, 572	5, 552	35, 133	19, 891	5, 250	83, 346
1940	2, 985	10, 415	4, 491	29, 620	19, 371	6, 405	73, 287
1945	2, 272	6, 654	3, 670	26, 198	22, 004	7, 975	68, 773
1950	1, 900	5, 205	3, 340	23, 317	22, 138	8, 831	64, 731
1955	1, 632	4, 462	2, 831	20, 337	21, 999	9, 925	61, 186
1960	1, 451	3, 277	2, 166	15, 596	20, 672	11, 364	54, 526

Data from U.S. Census of Agriculture.

many similar cases, the data on individual movements are not available. The quinquennial U.S. Census of Agriculture, the best known source of data on farm numbers in North Dakota, records only the number of farms in each of several size groups as of the date of enumeration (table 1). With census data alone it is not possible to determine whether the farms in a given size group at a given time are the same farms that were in that size group at a preceding time or are farms that have "moved" from other size groups. In the absence of detailed data on individual movements, the Markov process loses some of its usefulness as an analytical tool. Detailed data on farm movements would provide the means for a useful analysis of farming careers along with the changes in farm size. However, with appropriate assumptions the data available can be recast in such a way that a Markov chain analysis is possible.

To utilize census data, assumptions must be made regarding the movements of farms between size groups or states. These assumptions must be based on whatever knowledge the analyst may have regarding the population.

The following assumptions seem reasonable:

1. Operators of any size of farm in North Dakota would expand their acreage, if possible. This is a commonly expressed opinion of farmers and is consistent with production cost data which indicate some economies of size in farming (*4*).

2. The farms most likely to expand are those that are initially larger than average. This is likely to be true for the size groups here dealt with. The available cost data indicate that these larger farms have lower production costs and hence should be in a better financial position to purchase land. They may also gain further cost economies by further expansion.

3. Increases in farm size are likely to come about by gradual increases in acreage. This is true because of the problems of finding additional land for sale in the community and of financing land purchases.

4. Decreases in size of farms are not likely to occur. Again, because of the existing economies of size, decreases in size of units are not likely to be made voluntarily. A farm is more likely to disappear as a farming unit than to become smaller.

These assumptions give rise to the following rules for determining the transition of farms from size state to size state.

1. Farms in the largest category, S_6, remain in this category.

2. Increases in number of farms in any state S_i come from the next smaller state, S_{i-1}.

3. Any decrease in number of farms in any state (other than from rule 2 above) results in a movement to S_0, i.e., they are assumed to go out of business rather than move to S_{i-1}.

An appropriate base period is an important consideration for any set of projections. The choice of a base period for a transition matrix becomes especially important when the rate of change has been as variable over time as in this instance (table 2). Although several base periods were used in constructing the transition matrix, results presented here were based on the 1935–60 period.[2]

[2] As indicated elsewhere in this paper, there are really two kinds of base periods: one is the base for determining the transition matrix, the other is the base used as a starting point in making number projections. Both are necessary.

TABLE 2.—*Percentage rates of decline in farm numbers in North Dakota*

Period	Decline in 5-year period
	Percent
1935 to 1940	12.07
1940 to 1945	6.16
1945 to 1950	5.88
1950 to 1955	5.48
1955 to 1960	10.88

The heart of the Markov process is the matrix of probabilities of movements of farms from size state to size state. This transition matrix is determined by the following procedure. Using the above rules for farm movements and the census data for 5-year intervals, a flow chart is developed for each 5-year interval. Each flow chart, when completed, shows the estimated movements of farms from state to state during a period. Table 3 illustrates the estimated transition for the period from 1935 to 1940. The beginning and ending numbers of farms in each group are known (column and row totals). From this we proceed to estimate the individual movements that took place between time periods. We start with S_6 (this is not necessary but it is convenient). To obtain 6,405 farms in S_6 in 1940, we retain the 5,250 farms that were in S_6 in 1935, and show a movement of 1,155 farms from S_5 in 1935 to S_6 in 1940. This leaves 18,736 farms in S_5 for 1940. However, we need a total of 19,371 in S_5 for 1940 so we must transfer 635 farms from S_4 in 1935 to S_5 in 1940. This leaves 34,498 farms in S_4 but we only need 29,620 in S_4 for 1940. Hence the remaining 4,878 farms are transferred to S_0. This procedure is continued for the remaining cells until the totals all balance.

The same procedure is repeated for each 5-year interval. When all the tables are completed (for five intervals in this case), like items in all of the tables are added. For instance, the items S_{56} (row 5, column 6) from table 3 will be added with S_{56} from each of the other tables. The same addition is performed on the row totals. The individual items in the table of totals are then divided by the row totals. This gives an average of the transitions between states as a percentage of the firms in each state. These percentages are then entered in the transition probability matrix.

The transition matrix, with 1935 to 1960 as the base period, is as follows:

$$P = S_3 \begin{array}{c} \\ S_0 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{array} \begin{array}{c} \begin{array}{ccccccc} S_0 & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ .1958 & .8042 & 0 & 0 & 0 & 0 & 0 \\ .2554 & 0 & .7446 & 0 & 0 & 0 & 0 \\ .1307 & 0 & 0 & .8301 & .0392 & 0 & 0 \\ .0997 & 0 & 0 & 0 & .8491 & .0512 & 0 \\ 0 & 0 & 0 & 0 & 0 & .9420 & .0580 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \end{array} \quad (2)$$

TABLE 3.—*Estimated transitions of farms in North Dakota from 1935 to 1940*

Size group in 1935	Size group in 1940							
	S_0	S_1	S_2	S_3	S_4	S_5	S_6	Total
S_0	0	0	0	0	0	0	0	0
S_1	963	2,985	0	0	0	0	0	3,948
S_2	3,157	0	10,415	0	0	0	0	13,572
S_3	1,061	0	0	4,491	0	0	0	5,552
S_4	4,878	0	0	0	29,620	635	0	35,133
S_5	0	0	0	0	0	18,736	1,155	19,891
S_6	0	0	0	0	0	0	5,250	5,250
Total	10,059	2,985	10,415	4,491	29,620	19,371	6,405	83,346

This matrix is typical of the transition matrices obtained regardless of the base period used. The coefficients indicate the percentage of the farms in S_i that will probably be in S_j after 5 years. The matrix is fairly sparse because of the type of data available and the need for making assumptions on the movements of farms. The sum of the coefficients in any row must always be unity if all farms are to be accounted for. Row S_0 indicates that no new firms are entering farming and column S_0 indicates that some farms from S_1, S_2, S_3 and S_4 are going out of business. State S_0 is an "absorbing state" as farms enter this state but do not leave it.

State S_6 (farms of 1,000 or more acres) also is an absorbing state. The number of farms in this category has been steadily increasing since 1935.

The matrix reflects the initial assumptions on movements of farms. The principal diagonal contains fairly large coefficients, which would indicate stability of farm size. But in this example the size of the coefficient is partially due to the assumptions on movements of farms. Data on actual farm movements would give a transition matrix containing many more nonzero elements and would thus reflect less stability. Certainly these movements take place but they cannot be identified from census data. One could "fill" these cells by changing the assumptions about movement of farms, but the resulting coefficients would have little meaning. It was found that other sets of assumptions regarding movements of farms produced different projections for the individual states but had little effect on the projected totals. The change in the totals is related to the historical average change in farm numbers in the base period.

The coefficients in the transition matrix provide some worthwhile information not readily available from other types of projections. For instance, the coefficients in row S_3 indicate that approximately 13 percent of the farms of 180 to 259 acres will probably go out of farming in any 5-year period. Of this same group, 83 percent will remain in the same size state and 4 percent will expand to 260–499 acres in any 5-year period. In comparison, 5.1 percent of the farms in S_4 will probably expand to S_5 in 5 years and in the same time period 5.8 percent of the farms in S_5 will probably expand to S_6. On the other hand, farms smaller than S_3 are not likely to expand. However, the transition matrix also indicates that farms of 500 acres or more (S_5 and S_6) do not go out of business. Clearly, it would be much more meaningful if these items of information were based on data for individual farm movements instead of assumptions.

Projecting Farm Numbers

The projections of farm numbers can be obtained with the use of the transition matrix by either of two slightly different methods. The most commonly used method is to multiply the P matrix by itself n times to obtain the probability of movements during n time periods. Individual elements of the desired P matrix are then multiplied by the farm numbers in their respective size states in the base year, or period, used for projection. An alternative method is to multiply the distribution of farms in the base year for projection by P to obtain the projections for one period and continue to postmultiply the results by P for the desired number of periods. The latter procedure has the advantage of giving projections for each time period, in this case every 5 years, and is simplest in this case since the transition matrix is relatively sparse.

In this paper, the first projection base is 1935. The first year in the base period for estimating the transition matrix was used as the projection base. But the P^n matrix could be applied to any other year or base that seemed appropriate. It might sometimes be more reasonable to make this application to the most recent information about the number of farms in different size groups. Taking an earlier base may give estimates for later years which do not agree with known numbers. In the present study, using a 1935 base for projections gives estimates of farm numbers for 1960 that agree very closely with the actual numbers in 1960.

The resulting estimates of the total number of farms for 1975 and 2000 show some differences between projections that are due to selection of different base periods (table 4). The rate of decline in total number of farms is related to the average rate of decline in the base period, although this is not a 1-to-1 relationship.

The projected distribution of farms for 1975 and 2000 indicates differential rates of decline in farm numbers by size categories (table 5). Comparisons with table 1 indicate the magnitude of changes that can be expected for each size group. The pro-

TABLE 4.—*Projected number of farms in North Dakota using different base periods for the transition matrix*

Base period	Projected number of farms for—		Projected decline in number of farms from 1960 to—		Average rate of decline per year
	1975	2000	1975	2000	
	Farms	*Farms*	*Farms*	*Farms*	*Percent*
1935 to 1960	46, 814	41, 247	7, 712	13, 279	1. 37
1945 to 1960	46, 854	40, 057	7, 672	14, 469	1. 38
1950 to 1960	45, 614	38, 507	8, 912	16, 019	1. 58
1955 to 1960	42, 511	35, 275	12, 015	19, 251	2. 18

jections have many implications for present farmers and for young people contemplating farming as a career.

The Markov process also allows the estimation of several other parameters that may be of interest. With two absorbing states, S_0 and S_6, the transition matrix (2) can be rearranged as in equation (3).

If the southeast submatrix of equation (3) is designated Q, then where I is an identity matrix, $[I-Q]^{-1}$ gives the mean number of periods in each transient state for each initial nonabsorbing state. Multiplying this matrix by the scalar 5 (5-year periods) converts these estimates to years. Equations (3) and (4) are given below.

TABLE 5.—*Projected number and distribution of farms in North Dakota (transition base=1935–60)*

Size of farm	1975	2000
	Farms	*Farms*
S_1 (10 to 99 acres)	691	232
S_2 (100 to 179 acres)	1, 282	294
S_3 (180 to 259 acres)	924	364
S_4 (260 to 499 acres)	9, 925	4, 471
S_5 (500 to 999 acres)	19, 236	15, 924
S_6 (1,000 acres and over)	14, 756	19, 962
Total	46, 814	41, 247

$$P=\begin{array}{c} \\ S_0 \\ S_6 \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array}\begin{array}{c} \begin{array}{cc|ccccc} S_0 & S_6 & S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \left[\begin{array}{cc|ccccc} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ \hline .1958 & 0 & .8042 & 0 & 0 & 0 & 0 \\ .2554 & 0 & 0 & .7446 & 0 & 0 & 0 \\ .1307 & 0 & 0 & 0 & .8301 & .0392 & 0 \\ .0997 & 0 & 0 & 0 & 0 & .8491 & .0512 \\ 0 & .0580 & 0 & 0 & 0 & 0 & .9420 \end{array}\right] \end{array} \quad (3)$$

$$[I-Q]^{-1}\,(5)=\begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array}\begin{array}{c} \begin{array}{ccccc} S_1 & S_2 & S_3 & S_4 & S_5 \end{array} \\ \left[\begin{array}{ccccc} 25.54 & 0 & 0 & 0 & 0 \\ 0 & 19.58 & 0 & 0 & 0 \\ 0 & 0 & 29.43 & 7.64 & 6.75 \\ 0 & 0 & 0 & 33.13 & 29.25 \\ 0 & 0 & 0 & 0 & 86.21 \end{array}\right] \end{array} \quad (4)$$

Thus for a farm in S_3 the mean number of years before absorption by S_0 or S_6 is 29.43 years in S_3, 7.64 in S_4, and 6.75 years in S_5. For farms in S_2 the mean number of years before absorption is 19.58. These estimates are another indication of the rate of change in number of farms by size of farm. These estimates do not mean, for example, that in 19.58 years the number of farms in S_2 will be reduced to half the initial number. These estimates are *mean number of years* of a firm in a state and *not the years needed to reach the mean number*. Actually, the number of farms in S_2 will be reduced to 50 percent of the initial number in approximately 12 years, and to 5 percent in 50 years.

Another set of estimates available with the Markov process is estimates of the equilibrium distribution of firms. Equilibrium in a Markov process has been interpreted by Adelman as follows:

> [Equilibrium] may be defined as that distribution for which the average number of corporations entering a given stratum per period equals the average number of businesses leaving it. Our concept of equilibrium is statistical in nature for the industry, and dynamic for the individual firm. In other words, equilibrium in this paper does not imply that there is no movement of enterprises between strata. On the contrary, the stochastic conception of equilibrium explicitly requires that firms move in and out of each class. But on the average, forces acting to increase the number of enterprises in a given size range are exactly counterbalanced by those tending to decrease it (*1*, pp. 895–96).

With absorbing chains, all equilibrium distributions will consist of firms in only the absorbing states, in this case S_0 and S_6. In other words, it is assumed that all farms will either go out of business or consist of 1,000 acres or more. Hence the estimates of the equilibrium distributions with absorbing states lead to trifling results.

However, it may be of interest to know what the number of surviving farms may be. This can be arrived at by first estimating the probability that firms in each nonabsorbing state will end up in each absorbing state. If the southwest submatrix of equation (3) is designated R, then:

$$[I-Q]^{-1}R=\begin{array}{c} \\ S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{array}\begin{array}{c} \begin{array}{cc} S_0 & S_6 \end{array} \\ \left[\begin{array}{cc} 1 & 0 \\ 1 & 0 \\ .9217 & .0783 \\ .6607 & .3393 \\ 0 & 1 \end{array}\right] \end{array} \quad (5)$$

The elements of equation (5) indicate the probabilities of absorption of states S_1 to S_5 by states S_0 and S_6. As shown, the probability is 1 that S_1 and S_2 will be absorbed by S_0. This was obvious from the transition matrix. S_5 eventually will be absorbed into S_6. Farms in S_3 and S_4 will be absorbed by either S_0 or S_6. Ninety-two percent of the farms in S_3 and 66 percent of the farms in S_4 will be absorbed by S_0. Thus the number of remaining farms will be approximately 8 percent of the farms in S_3, 34 percent of S_4, and all of the farms in S_5 and S_6, a total of 37,500 farms (1935–60 base period). In contrast, use of the 1955–60 base period gives an estimate of 32,400 as the number of surviving farms.

Reliability of Estimates

Statistical tests of the reliability of these types of projections have not been developed. The method assumes that the probability for the farms in any one size group moving to another remains constant over time. But this assumption becomes increasingly unrealistic as times goes on. Conceivably, some farmers may have been adjusting rapidly to a change in technology during the base period. The remaining farmers may not adjust in the same way or at all. But the procedure assumes that they behave in each size group just as they did during the base period.

Another possible inconsistency has to do with the relationship between average numbers and average sizes of farms in each size group. With a relatively fixed total acreage of farmland in North Dakota, the projected increase in farm numbers in the larger groups means that the average size in one or more of the size groups must fall. This may be all right, but it raises a question about whether the Markov process results in the most reasonable allocation of the changes between numbers and sizes.

Regression techniques using a single independent variable can be used to make similar projections by extrapolation. Such methods embody many of the same sets of assumptions as those implied in the Markov chain. Regression techniques do permit the calculation of errors of estimate or confidence intervals for estimates within the range of the data. But when the technique is used to project an estimate outside of the range of the original data, the confidence limits are no longer applicable. One advantage of simple re-

gression analysis is that the procedure is already understood by most economists.

The estimates presented in tables 4 and 5 are conservative in the opinion of the writer. Many people would predict even fewer farms for 1975 and 2000 than any of the above estimates. One's thinking is likely to be influenced most by more recent events and hence one might be more inclined to accept estimates based on the recent period, 1955–60. Even these estimates look fairly reasonable, although they indicate a more drastic decline in farm numbers than projections based on the longer periods.

Concluding Remarks

The procedure, as illustrated, has several shortcomings: (1) No statistical measures of reliability are available, (2) only net movements can be measured, and (3) for North Dakota more size categories in the census classifications would be desirable. The 1959 Census of Agriculture included an enumeration of farms of 2,000 or more acres. This is highly desirable since the projections indicate that eventually most of the farms in North Dakota will consist of 1,000 acres or more. With data on actual farm movements between size states much more useful information could be obtained.

The use of Markov chains to project future number of farms has several advantages over traditional procedures. The following are the most important:

1. Projections can be made more conveniently for each size category of farms.

2. The method provides other types of estimates which are not readily obtainable with traditional techniques.

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Book Reviews

Government and Agriculture: Public Policy in a Democratic Society

By Dale E. Hathaway. The MacMillan Company, New York. 412 pages. 1963. $8.95.

MOST PROFESSIONAL BOOKS are easy for me to lay aside at the sound of mess call or taps. Professor Hathaway's book on policy was not one of them. This means that it was easy to read and that I became fascinated with the tidbits of observation about agriculture and farm policy which turned up every few pages.

Hathaway makes a point in his preface that the book is *about* agricultural policy rather than a *history* of policy or an examination of what policy *ought* to be. While he may play on words here, history is dragged in incidentally where needed for understanding. And you get the author's view of what *ought* to be only by implication and by a bit in the very last chapter where he talks about the future of farm policy.

I should add, as the author does, that he deals only with some farm policies. He talks mostly about price and income policies with a dip here and there into policies relating to the low income and employment problem of rural people. He completely ignores policies relating to conservation, resource development and management, standards and quality of farm products, and many other facets of public action affecting farm people and farm products. He mentions many others only incidentally. The book should not be criticized on this account, however, because he tells you in the beginning that he concentrates on price and income policy.

Government and Agriculture is built around four major parts: The pressures for public action, the economics of the farm problems, the process of policy formation, and potentials and obstacles of selected policy alternatives.

The first part begins with a description of beliefs and values underlying policy—the things people desire. Here the author properly points out the complexity and inconsistency of many of these desires. He could have emphasized that inconsistency in desires often occurs within individuals as well as between groups. For example, many policy leaders fail to see conflict between the desire for favorable, stable incomes and unfettered production, or between the desire for economically adequate family farms and a maximum number of opportunities to farm.

The first part of the book continues with an examination of gaps between desires and reality and how desires get translated into policy goals. There is little here that is new to students of policy, although it is well stated and worth scanning.

The second major part deals with the economics of the farm problems. Here the author draws heavily on the scholars of the field including himself, Cochrane, Galbraith, D. Gale Johnson, Glen Johnson, Heady, and many others. The author's contribution is chiefly one of bringing together and critically examining most of the modern ideas about the economics of farming. (I use "farming" here instead of "agriculture" because little is said about factor-producing industries or the product-marketing industries.)

Hathaway cleverly makes one point by talking about "why farmers are underpaid but not always poor" (ch. 4) and about "those who are poor but not always underpaid" (ch. 6).

The most interesting, and at the same time least satisfying, section of the book discusses the process of policy formation (part 3). Unlike the previous part, here the author fails to avail himself of much of the relevant literature. In fairness, a full treatment of this subject would require far more than the 53 pages used.

Hathaway does make the proper point that policy formation is a complicated stew made by many different cooks each following different recipes or none at all. The Congress, the White House, the Bureau of the Budget, the Secretary of Agriculture, the U.S. Department of Agriculture, the general farm organizations, the special farm orga-

nizations, committees, commissions, and occasionally just citizens—all add to the pot, taste the results, and wonder whether the broth is overdone or yet too raw. The author tells about the growing influence of commodity-oriented organizations, but he fails to emphasize it; he does not even mention the American National Livestock Association.

The fourth part of Hathaway's book treats, in very general terms, with broad policy alternatives. Here he poses the key questions of the entire book: "(1) will agriculture suffer from chronic disequilibrium in the market economy and, (2) if so, what are the probable impacts of various policies to either reduce the tendency to chronic disequilibrium or keep it within 'acceptable' levels."

Hathaway concludes, reluctantly it seems, that the market cannot achieve equilibrium for agriculture. In this, he is in good company, albeit perhaps not a large one.

Hathaway does not say anything very favorable about policies to change the demand for farm products. "None of the programs influencing the demand for farm products can appreciably improve the poverty problem in agriculture . . . [nor are they] particularly effective in dealing with . . . change in output . . . " "The complete inability of a price support program to deal with the equilibrium problem in agriculture has been amply demonstrated over the past decade."

He does not think much of land retirement; ". . . it offers at best a poor way of controlling farm output." He dismisses possible control of other inputs with hardly a word.

He then makes a brief bow to programs outside of agriculture including training and other devices to make farm labor occupationally mobile. But ". . . labor mobility in agriculture, by itself, is unlikely to be sufficient to bring returns for human effort in agriculture up to returns elsewhere in the economy." I agree; so do many others who have examined the place of labor in farming.

This all seems very confusing and, in fact, it is. Yet despite abundant skepticism, Hathaway concludes that farm policies have been successful. That is, farm people are better off than they would have been without them, the Nation is well fed at low cost, and so far we have avoided a "peasant" rural class.

After some passes at our "conventional wisdom," Hathaway offers economists nothing but a frustrating role in farm policy matters of the future. He says we should develop better information, and suggests little for economists but to keep trying.

I would put this book on the required reading shelf for all who think or think they think about farm policy. It is easy to read, free from complex algebra, and covers pretty well that part of farm policy in greatest recent controversy. Congressmen, college students, and county committeemen will find facts here they need to know.

M. L. Upchurch

State Individual Income Taxes—Impact of Alternative Provisions on Burdens, Progression, and Yields

By Emanuel Melichar. The University of Connecticut, Storrs Agricultural Experiment Station. 275 pages. 1963. $2.50.

WITH THE FIVEFOLD postwar growth of State and local expenditures, and the accompanying concern with ways of financing these expenditures, Melichar's analysis of State income taxes will be of great interest to students of public finance. Furthermore, as discussions in many of the States involve the possible use of the income tax to modify the property tax burden on farmers, Melichar's study will interest agricultural economists as well.

Melichar begins by tracing the history of State income taxation from the "faculty" tax of colonial times through the adoption by Wisconsin in 1912 of the first modern State income tax, and to the present use of the income tax by 33 States and the District of Columbia. He describes State individual income tax revenue from 1912 to 1960, and describes and compares State tax provisions in 1960.

In the following sections—the real meat of the analysis—Melichar measures the progressivity of the income tax in each State that uses it. He discusses the various provisions regarding deductibility of the Federal income tax, State personal exemptions, and income splitting, and the relative burdens of the State taxes on taxpayers at different income levels.

The study includes an excellent discussion of the concept of the net burden of the State tax—the amount by which the combined State and Federal income tax bill rises as a result of the State tax. Because the State income tax is deductible from

income in calculating the Federal income tax (and in 20 States all or part of the Federal tax can be deducted from income for State tax purposes), State taxes are paid partly with dollars that would otherwise have gone into Federal taxes. For example, a taxpayer in the 74 percent marginal tax bracket on the Federal income tax, living in a State that does not permit Federal deductibility, will find his total Federal and State tax bill rising by another 26 cents for every dollar rise in his State tax bill. In view of the sharply rising marginal Federal tax rates in the higher income brackets, it is not surprising that Melichar finds that the net burden of the State income tax is regressive in every State, in at least some of the higher income brackets. The new Federal tax rates will change the net burdens of the State taxes somewhat, but it seems unlikely that they will materially affect the value of Melichar's study.

Appendix B of the study will be of particular interest to research workers in agriculture. In this section, Melichar has estimated the size and distribution of the burden on Connecticut farmers of an income tax modeled after each of the State taxes now in use. The taxes that would have been collected from the 5,800 Connecticut farmers in 1956 range from $9,900 under the rates and provisions of the Louisiana tax to $191,500 under the Hawaii provisions. Also included are estimates of the distribution of the tax by net farm income. Melichar's estimates are based on a special tabulation of net farm earnings grouped according to size of earnings, obtained from social security data. Both his methodology and his conclusions should be useful to workers concerned with these problems in other States.

The reader who is interested in a quick introduction to the field of State income taxation will probably find Melichar's book both too limited in scope and too detailed for his needs. The reader who wishes to go into the field more deeply, however, will find the book invaluable.

Thomas F. Hady

Challenge to Affluence

By Gunnar Myrdal. Random House, New York. 172 pages. 1963. $3.95.

PROFESSOR MYRDAL presents in this informative and provocative book a challenge to American economic growth. His appraisal of our current economic and socioeconomic problems is presented in a straightforward and concise manner. He directs his attention to our problems of economic stagnation, structural unemployment, and international economic relations. His discussion suggests the following questions: What would happen to U.S. foreign policy if, weakened and frustrated, we found ourselves unable to meet the Soviet challenge? What would happen to the structure of our society if low growth rate and rising unemployment became increasingly permanent parts of our economy?

The book is divided into two parts: Part I deals with economic stagnation in America; part II evaluates international implications of this stagnation. The author includes in the appendix an address given at Howard University in 1962 in which he discusses the role of the middle-class Negro in our society.

Professor Myrdal stresses the need to expand the aggregate economy by enlarging capital investment outlays in the public sector along with increases of capital investments in the private sector of the economy. The end result would be an increase in the U.S. growth rate and, in turn, less unemployment.

The thesis of this book is that it will not prove possible to change over the American economy to rapid and steady growth and full employment without taking vigorous measures to induce greater equality of opportunity and of standards of living.

> Economic expansion, which is not just rapid but steady, is only possible if huge reforms are made in the interest of social justice. Otherwise, it will be impossible to maintain a steady rise of total demand, and the supply of labor will not be fitted to the demand for labor. The induced expansion will soon turn into a new recession. The reforms will necessarily imply very substantial increases in public expenditures.

Professor Myrdal evaluates some very important problems where analyses in depth are needed in order to plan and develop effective short- and long-run economic policies and programs.

This book should be read by all who are interested in the future growth of the American economy. Economists, administrators, and policy makers will find this study of great value in appraising the major problems facing our economy today.

C. B. Singleton, Jr.

Livestock and Livestock Products

By Theodore C. Byerly. Prentice-Hall, Inc., Englewood Cliffs, N.J. 422 pages. 1964. $10.

IN UNDERTAKING the monumental task indicated by the title, Dr. Byerly appears to have been well aware of the necessity to limit specific detail in order to gain broad coverage. His book is directed toward helping those with a minimum of training in livestock management to understand and solve common livestock production problems.

The core of the book appears to be the 4th through the 15th chapters, which cover topics such as heredity and livestock breeding, reproduction, lactation, nutrition, feeds and feeding, livestock health, livestock quality, and meat quality. The background and industry setting are covered in the first three chapters, while product utilization, marketing, and costs and returns from livestock farming are covered in the last three chapters.

Chapters 4 to 15 contain general and specific information about the technical aspects of livestock production which will be beneficial to the student or producer who knows little about livestock and needs a starting place he can grasp. This approach may be less helpful in the rest of the book. Farm management today is increasingly scientific. Farmers recognize that decisions, if they are to be profitable, must be made on the basis of expected costs and returns from possible alternative courses of action. The farmstead environment on profitable farms is increasingly a result of such informed decisions, as are the farm organization and the resultant pattern of marketing. I believe these sections would have been more helpful if Dr. Byerly had talked about alternatives, criteria, and decisions a great deal more, even at the expense of descriptions of techniques livestock raisers or feeders have used and ways producers have found to do things.

The reader with the minimum of training will find the more detailed chapters on the technical aspects of production somewhat more applicable to his problems than the sections on farm management, farm environment, or marketing. However, these sections also will be useful in developing a perspective of animal agriculture in the United States.

William C. Motes

The Economics of the Wartime Shortage

By Mancur Olson, Jr. Duke University Press, Durham, N.C. 152 pages. 1963. $4.50.

THE AUTHOR challenges the assumption that shortages of food and other raw materials are more serious than shortages of products manufactured from them. His challenge is based on an examination of economic theory and of Great Britain's wartime experience.

The assumption that a shortage of food is particularly critical is traced back to the discredited physiocratic theory that all wealth comes from the earth. There is no relation between the tragedy which would result from a total loss of food supply and the problems of adjusting to a partial loss of the normal supply. The author points out that it is not the type of commodity but the type of use which distinguishes a luxury from a necessity, and that food has many low-priority or inessential uses.

British experience during the Napoleonic War and World Wars I and II is used to demonstrate the weakness of the idea that food is more essential than most other types of goods when partial loss of supplies is at issue. Great Britain was able to overcome similar supply problems in each of the three major wars.

The British performance was particularly remarkable during World War II when the food problem was most serious. British food and feed imports were reduced from 20.7 million tons in 1939–40 to 10.3 million tons by 1942–43. Despite this drop in imports, the health of the British people actually improved. This extraordinary achievement cannot be attributed to prewar preparation or to any peacetime expansion of agriculture.

Britain's success is largely attributed by the author to its advanced techniques in administration of science and government. Although Britain's experience bolsters Olson's argument that a loss of food imports is not necessarily worse than a loss of other kinds of imports, he notes that the British Government appears to have reached a different conclusion. The tendency of British postwar policy has been to increase domestic food production and to keep a stockpile on hand. Olson questions this conclusion and suggests: "It may be that if any one kind of production is to be

singled out as most critical, it should not be the production of food or raw materials but the production of a skilled and versatile people. Perhaps tertiary industries like the educational 'industry' ought to be expanded, rather than the primary industries."

The author suggests that protection of primary industries like agriculture by tariff and the stockpiling of food may be harmful as well as unnecessary:

> The protection by tariff of domestic primary industry, and to a lesser degree stockpiling, also tend to hurt a nation's strength by damaging its relation with others . . . barriers against international trade can deprive a nation of that "dependence" on foreign nations which makes neutrals out of enemies and allies out of neutrals.

Few will disagree with the author's conclusion that "need for a resourceful, disciplined, and well-managed people would reach unprecedented heights" in the event of a nuclear war. However, issue will be taken with his accompanying statement that the amount of a nation's food and raw materials would be the least of its worries.

Shortages of food may be no more serious from an economic standpoint than shortages of other commodities, given a highly developed industrial economy and a long war period in which adjustments can be made, but fear of shortages can have a particularly devastating effect on morale. The author does not discuss food stockpiling during World War II in relation to the postwar world food famine nor the fact that serious restrictions on British food consumption were required until 1950.

Man's need for assurance of enough and palatable food increases as he faces fear of the unknown. The author does not discuss the importance of food to man's mind and morale.

Gladys L. Baker

Rural Revolution in France—The Peasantry in the Twentieth Century

By Gordon Wright. Stanford University Press. Stanford, Calif. 271 pages. 1964. $6.

THE AGRICULTURE of France, long dominated by "small peasant production," has undergone and is undergoing a great change. Pressures on the agricultural sector throughout Western Europe are similar to those that exist in the United States. Agriculture's share of gross national income is declining rapidly in France, and population has shifted out of agriculture as productivity per person has increased.

Wright, in this book, has highlighted the political and administrative aspects of this rural revolution. It is safe to say, and the case is documented, that the peasantry has been a traditional force in holding back agricultural change. The peasantry and supporting groups did this in what was thought to be self-interest. The struggle away from traditionalism has been characterized by much political action with direct involvement by special-interest groups with their own specific approaches to the problem. Wright points out that it is only since World War II that the countryside 'revolution really got underway. One might say similarly that the more rapid changes of our own U.S. rural revolution occurred in World War II and the years just after. The obvious force in the village countryside revolution has been the technology that has pervaded all modern agriculture. The French peasant, and France as a country, could not be bypassed in such a revolution.

The author has made the chronicle more interesting by adding an appendix which describes the revolution in six different village settings. What has happened among the peasantry is made more vivid by this presentation.

This book is not only interesting reading, but it is informative for those who wish to know something about agriculture in the most important agricultural country of Western Europe. One who reads this small book analytically should gain understanding of some of the direction of French agriculture vis-a-vis the Common Market and our own market interests in Western Europe. The volume is recommended to those with the above interests in mind as well as for those who are students of agricultural change.

John H. Southern

Experiments on a Simulated Economy: Development Plans and Balance-of-Payments Policies

By Edward P. Holland with Robert W. Gillespie. The M.I.T. Press, Cambridge. 289 pages. 1963. $8.

TWO IMPORTANT subjects are dealt with in this book: computer simulation of economic systems and its application to the study of alternative economic policies for an underdeveloped

country. The country studied is India. The economic policies examined are alternative development plans and foreign trade policies.

This combination of subjects should interest many economists. However, the book is more an assembly of working papers intelligible only to the authors than a good piece of exposition.

The volume has three fundamental weaknesses. First, the reader is not very well informed as to what simulation is all about. It is not until the reader reaches chapter 9, "Is Simulation a Valid Technique?," that he gets an introduction to what simulation is. This chapter should be in first rather than ninth place in the order of presentation. Even so, this is, at best, a cursory introduction. Here and elsewhere the reader is given only the most general idea of how to go about constructing and using a simulation model. This is not a book from which the neophyte can readily learn to be a simulator.

Second, the economic models used in the study are not presented and discussed in the text. Rather, they are presented in the appendix in computer language. The economic models remain a mystery to those who are not conversant with this "alien tongue."

Finally, there is too much unexplained notation in the book. For example, for each five sectors of the economy studied there are alternative investment plans. Thus, a particular combination of these plans might be AEAGF where the first sector adopts plan A, the second plan E, etc. The reader of this review now knows almost as much about the specific nature of these investment plans as the reviewer—virtually nothing.

It is unfortunate that the authors did not do a better job of presenting their study—simulation of an underdeveloped economy. Simulation is a promising technique, particularly in the area the authors have examined. Also, the Indian economy is the unit of inquiry and there are many economists who are very interested in it.

In closing, a quote from St. Paul (First Epistle to the Corinthians, ch. 14, verse 9) seems appropriate: "So likewise ye, except ye utter by the tongue words easy to be understood, how shall it be known what is spoken?"

Martin E. Abel

Agriculture in India: Volume I, General, Volume II, Crops

By L. S. S. Kumar, A. C. Aggarwala, H. R. Arakeri, M. G. Kamath, Earl N. Moore, and Roy L. Donahue. Taplinger Publishing Co., New York, for Asia Publishing House. 252 pages, 243 pages. 1963. $7.50, each volume.

THESE TWO VOLUMES, to which a third on animals will be added later this year, were prepared by a team of Indian and American scholars for use as text books in the secondary schools of India. Consequently, as Dr. George Montgomery declares in his introduction, they are "easy to read, comprehensive, practical, conveniently arranged, and well illustrated" (p. ix).

Their value to the readers of this journal lies in the introduction they give to Indian agriculture, useful to one beginning to study this subject as well as to one preparing to serve as a technical assistant in India.

The first five chapters of volume I are of particular interest to the economist. They review the organization and role of the village councils, land reform, farmers' cooperatives and organizations, agricultural services of the Government, and farm management. The chapter on cooperatives describes the various cooperatives being used in India as well as the Farmers Forum. Yet these chapters are very brief and simple, covering 37 pages. The rest of the volume deals with plant structure and physiology—basic botany—agricultural chemistry, climate and soils, tillage and fertilizers, and irrigation. After reminding the readers that "India irrigates approximately one-fourth of the total land irrigated in the world" (p. 209), the authors provide descriptions and illustrations of the water lifts followed by descriptions of irrigation methods.

The second volume describes the culture and varieties of crops grown in India—rice, wheat, millet, legumes, oilseeds, sugarcane, cotton, jute, coffee, tea, papaya, and many others.

Both volumes are provided with useful indexes and glossaries.

Robert G. Dunbar

Selected Recent Research Publications in Agricultural Economics Issued by the U.S. Department of Agriculture and Cooperatively by the State Universities and Colleges[1]

Botts, Ralph R. FARMERS' HANDBOOK OF FINANCIAL CALCULATIONS AND PHYSICAL MEASUREMENTS. U.S. Dept. Agr., Agr. Handbook 230, 55 pp. Revised March 1964.

Modern American farming is a complex business operation. As farms get bigger and investments higher, more and more figuring is required to determine the costs and returns of the farm business and such things as depreciation, Social Security, credit, life insurance, retirement, and estate planning. This report presents calculations in question form with detailed solutions which county agents, State and Federal employees, and others can use to help farmers who ask them for advice.

Brown, Sidney E. RETAIL SALES OF BROILERS AND MEAT AS AFFECTED BY PRICE, DISPLAY AREA, AND NEWSPAPER ADVERTISING. U.S. Dept. Agr., Econ. Res. Serv., ERS–180, 12 pp. May 1964.

Sales data from a 6-week test in two Ohio cities were analyzed to determine the effects of week-to-week changes in prices and merchandising practices on broiler sales. Fluctuations in broiler tonnage in the 12 sample stores were found to be explainable chiefly by changes in broiler price, display area, and newspaper advertising.

Butz, William T. LONG-DISTANCE SHIPMENT OF MARKET MILK. U.S. Dept. Agr., Mktg. Res. Rpt. No. 648, 12 pp. March 1964.

Between the midfifties and the early sixties, long-distance shipments of market milk declined. The main factors in this decrease were the general uptrend in marketings of milk even in deficit milk-producing areas and the development of surplus producing areas closer to these deficit markets.

Cable, C. Curtis, Jr., Harvin R. Smith, and Zolon M. Looney. COMPARISON OF MECHANICALLY DRAWN SAMPLES WITH CUT SAMPLES FOR EVALUATING COTTON QUALITY. U.S. Dept. Agr., Mktg. Res. Rpt. 654, 28 pp. April 1964.

A study of 800 bales of cotton showed that mechanical samples drawn during ginning were about as reliable and useful for merchandising purposes as cut samples taken immediately after ginning. The average bale value and average grade were slightly higher and average staple length was slightly lower for mechanical samples than for cut samples. However, average values differed by only 10 cents per bale, and none of the differences were statistically significant.

Christensen, Raymond P., William E. Hendrix, and Robert D. Stevens. HOW THE UNITED STATES IMPROVED ITS AGRICULTURE. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-76, 32 pp. March 1964.

This report was prepared at the request of AID to show less developed nations how the United States has been able to achieve rapid increases in farm productivity. The report emphasizes the need for information about price and other economic incentives, fertilizer production and distribution, and knowledge of other factors which are important in raising farm output.

Corkern, Ray. KENAF: A BIBLIOGRAPHY, 1950-62. U.S. Dept. Agr., Econ. Res. Serv., ERS-153, 16 pp. January 1964.

Kenaf is a long-fibered annual pulp crop which is a potential source of raw material for the paper and pulping industry. This bibliography should aid market researchers and others appraising kenaf as a possible cash crop for the United States.

Coyner, Mary S. NICARAGUA: RECENT SHIFTS IN FARM OUTPUT AND TRADE. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-77, 15 pp. March 1964.

Nicaragua's economic situation has brightened considerably in the past 3 years, due largely to good crops—particularly the cotton crop. The estimated gross national product, of which about 40 percent is derived from agriculture, increased by almost 5 percent in 1962 over 1961 (at 1961 prices) and a comparable increase probably occurred in 1963. The United States in 1962 supplied 50.4 percent of Nicaragua's total imports. The outlook for the immediate future is for the United States to continue supplying at least half of the country's imports of farm products.

Davis, Jeanne M. FARM VACATION ENTERPRISES IN OHIO. U.S. Dept. Agr., Econ. Res. Serv., ERS–164, 35 pp. May 1964.

Farmers face advantages and disadvantages in the vacation business. On the one side farmers have a chance to add to their income and meet people who bring new ideas and interests to the farm family. On the other side there is additional work in caring for guests, loss of privacy, and difficulty in spacing reservations over the entire summer. A few Ohio farmers grossed over $2,000 from this seasonal business in 1963, but other farmers were unsuccessful and had no paying guests.

Dennis, C. C., B. A. Dominick, and B. W. Kelly. THE GREAT LAKES TART CHERRY INDUSTRY: PRODUCTION COSTS. U.S. Dept. Agr., Econ. Res. Serv., ERS–171, 24 pp. May 1964. (N.Y., Pa., and Mich. Agr. Expt. Stations cooperating.)

If a producer of tart cherries is to break even, his trees must yield at least 2½ tons per acre when the farm sale price is 7½ cents per pound and production costs are $200 per acre. Yield per acre is a leading factor in cost per pound. The report considers costs of growing and harvesting tart cherries in Michigan, New York, Pennsylvania, and Wisconsin.

Edman, Victor G. PRICES AND SPREADS FOR FRESH FRUITS AND VEGETABLES SOLD IN SELECTED MARKETS, 1956–62. U.S. Dept. Agr., Statis. Bul. 340. February 1964.

[1] State publications may be obtained from the issuing agencies of the respective States.

In general, marketing margins in dollars increased from 1956 to 1962. In several instances, margins as a percentage of the retail price also increased. In some cases, price increases permitted both the margin and the grower's return to increase. The prices, margins, and grower's returns for 18 commodities are presented in 128 tables.

Gavett, Earle E. Labor Used To Produce Vegetables, Estimates by States, 1959. U.S. Dept. Agr., Statis. Bul. 341, 37 pp. March 1964.

The report presents the amount of labor used by crops, by States, in the commercial production of vegetables in 1959, and draws some comparisons with labor usage 20 years earlier in 1939. It is part of a continuing nationwide research program centered on agricultural production.

Hagenstein, Perry R. Factors Affecting the Location of Wood-Using Plants in the Northern Appalachians. U.S. Dept. Agr., Forest Serv. Res. Paper NE–16, 36 pp. 1964.

The costs of wood, labor, and shipping the final product to markets are the most important factors affecting the plant-location decision in four wood-using industries—lumber, particle board, woodpulp, and furniture. The relative importance of these factors varies considerably among the four industries examined.

Hair, Dwight. The Economic Importance of Timber in the United States. U.S. Dept. Agr., Forest Serv., Misc. Pub. 941, 91 pp. July 1963.

This report presents estimates of the value added and employment in timber-based activities in the United States in 1958 and 1954. Data are also presented showing the value of stumpage cut, the value of logs and related products harvested, the value of shipments from timber-based primary and secondary manufacturing industries, the value of construction, freight revenues from shipments of timber products, and wholesale and retail sales of timber products.

Hall, William F. Agriculture in India. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-64, 64 pp. January 1964.

Food production does not meet requirements in India although about half the land is used for agriculture and two-thirds of the people owe their living to farming. The land area of India is less than half that of the United States but the population is more than double. There is little more than one arable acre for each of the 300 million persons on farms in India. The Indian Government, with two 5-year plans, has had some success in initiating improvements in farming. India is now in its third 5-year plan.

Hanes, John K. The Organization of Wholesale Fruit and Vegetable Markets in Minneapolis-St. Paul and Duluth-Superior. U.S. Dept. Agr., Mktg. Res. Rpt. No. 647, 42 pp. March 1964. (Minn. Agr. Expt. Sta. cooperating.)

The Minneapolis-St. Paul market has changed from primarily a diversion and shipping point market to primarily a receiving market during the past 30 years. Nearby production of potatoes, fruits, and other vegetables for fresh market has decreased sharply. The number of fresh fruit and vegetable wholesalers in Duluth-Superior declined by almost one-half between 1939 and 1958.

Hodges, Earl F. Consumption of Feed by Livestock, 1940–59. U.S. Dept. Agr., Prod. Res. Rpt. No. 79, 94 pp. March 1964.

This report revises and continues the data previously published in 1958. Among other items, the report presents data on the relative value of feeds for different kinds of livestock with various prices for corn, methods of estimating future feed needs, and the quantities of feed, including pasture, consumed by various kinds of livestock annually.

Holder, Shelby H., Jr., and Zolon M. Looney. Reclaiming and Marketing Cotton Gin Motes. U.S. Dept. Agr., Econ. Res. Serv., ERS–168, 14 pp. May 1964.

Cotton gin operators may be able to increase their income by reclaiming gin motes—a byproduct of cotton ginning consisting of any gin waste usable for its fiber content. The largest outlets for this substance are the bedding, automotive, and furniture industries.

Langsford, E. L. Extent and Cost of Using Chemicals in Cotton Production: Selected Areas, 1961. U.S. Dept. Agr., Econ. Res. Serv., ERS–155, 15 pp. March 1964.

Insecticides, fertilizers, herbicides, and defoliants are becoming increasingly important in producing U.S. cotton. The estimated total costs of all specified chemicals for each acre of cotton averaged $17.74 for the materials plus $5.30 for their application. With an average yield of 410 pounds per acre planted to cotton, average costs for these chemicals were equivalent to 5.6 cents per pound of lint.

Manchester, Alden C. The Structure of Wholesale Produce Markets. U.S. Dept. Agr., Agr. Econ. Rpt. 45, 128 pp. April 1964.

Last of a series of reports on the organization and operation of wholesale fruit and vegetable markets throughout the country. It describes competition in the fresh fruit and vegetable business, the structure and organization of produce markets, the behavior of firms in these markets, and the efficiency with which markets of various types perform their functions.

Mighell, Ronald L., Lawrence A. Jones, and Earle E. Gavett. Contract Production of Truck Crops, 12 Selected Areas, United States. U.S. Dept. Agr., Econ. Res. Serv., ERS–152, 31 pp. March 1964.

Modern technology has increased the need for close coordination in truck crop vegetable farming that ties together successive stages in production and marketing. The results of this study show that contracting is more prevalent in the production of vegetables for processing while vertical integration in production is more common in vegetables grown for fresh market.

Moore, E. J., E. L. Baum, and R. B. Glasgow. Economic Factors Influencing Educational Attainments and Aspirations of Farm

YOUTH. U.S. Dept. Agr., Agr. Econ. Rpt. 51, 43 pp. April 1964.

Enrollment in college in 1960 was 33 percent among college-age rural farm youth and 34 percent among rural nonfarm youth. But among urban youth, enrollment was 48 percent. Rural education and services have not shared fully in national growth because of smaller school districts, low population density, and comparatively low incomes.

Patty, Gordon. CHILE: RECENT TRENDS IN AGRICULTURAL PRODUCTION AND TRADES. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-84, 12 pp. May 1964.

Chile is likely to be a good market for American wheat, dairy products, cotton, vegetable oils, tobacco, and rice for the next few years. Production of farm commodities in Chile has not kept pace with demand. Chile imported an average of $23 million worth of U.S. agricultural products yearly from 1959 through 1962.

Pavlick, Anthony L., and Robert I. Coltrane. QUALITY OF RURAL HOUSING IN THE APPALACHIAN REGION. U.S. Dept. Agr., Agr. Econ. Rpt. 52, 25 pp. April 1964.

The quality of housing in the Appalachian region is generally inferior to housing in other nearby areas and to the U.S. average. For every 100 housing units in the Appalachian region, 8 are dilapidated and 19 are deteriorating, while in the United States as a whole 5 are dilapidated and 14 are deteriorating. The Appalachian area includes 322 counties in Alabama, Georgia, Kentucky, Maryland, North Carolina, Pennsylvania, Tennessee, Virginia, and West Virginia.

Reutlinger, Shlomo. EVALUATION OF SOME UNCERTAINTY HYPOTHESES FOR PREDICTING SUPPLY. N.C. Agr. Expt. Sta. Tech. Bul. 160, 59 pp. March 1964. (U.S. Econ. Res. Serv. cooperating.)

Two supply models—a maximum expected profit model and a minimax model—were studied with the use of annual acreage and price data for cotton, wheat, and corn for the period 1909–32. By both models output was found to depend on a measure of central tendency as well as a measure of variability of the considered prices. The study presents some evidence that supply predictions are essentially the same regardless of which uncertainty hypothesis is assumed in specifying the supply model.

Richards, Stanley I. TRENDS IN INDIA'S AGRICULTURAL TRADE. U.S. Dept. Agr., Foreign Agr. Econ. Rpt. No. 15, 40 pp. February 1964.

India's agricultural exports, averaging over $500 million per year, account for about 40 percent of total foreign exchange earnings. Tea, the leading export commodity, accounts for half of all agricultural exports. The United Kingdom is India's leading export market, taking about half of its agricultural exports. The United States ranks second, importing an average of $84 million worth of farm products per year from India.

Sanderson, Agnes. FRENCH WEST INDIES: AGRICULTURAL PRODUCTION AND TRADE. U.S. Dept. Agr. Econ. Res. Serv., ERS-Foreign-80, 26 pp. April 1964.

The French West Indies, though its chief trading partner is France, is a small but growing market for U.S. commodities. French West Indies imports from the United States amounted to $4 million in 1961 and $5 million in 1962; exports to the United States in the 2 years amounted to $8 million and $6 million. Exports are mainly sugar and bananas. Imports comprise foodstuffs, almost all its manufactured goods, and all its petroleum products.

Skinner, Snider W. THE AGRICULTURAL ECONOMY OF THE IVORY COAST. U.S. Dept. Agr., Econ. Res. Serv., ERS-Foreign-69, 40 pp. April 1964.

Over 90 percent of the Ivory Coast population of about 3,400,000 is engaged in agriculture (including livestock raising) and forestry. In 1961, farm products made up 75 percent of all exports. Coffee is the Ivory Coast's most valuable commodity, and also its biggest economic problem. The Government is attempting to diversify agriculture by increasing production of such commodities as rubber and cotton.

Speel, H. C., and F. J. Poats. ECONOMIC POTENTIAL OF SOAPS, DETERGENTS, AND SURFACTANTS MADE FROM FATS AND OILS. U.S. Dept. Agr., Agr. Econ. Rpt. 53, 18 pp. April 1964.

"Soft" detergents that can be broken down in sewage disposal systems are expected to be generally available in 1965. Soaps and many of the surfactants made from farm-produced fats and oils are "soft," whereas petroleum-source surfactants do not break down rapidly in sewage. The petroleum industry is planning to synthesize surfactants that decompose more like those now obtained only from natural fats and oils.

Stewart, Clyde E. THE DESERT LAND ACT IN MID-TWENTIETH CENTURY: ISSUES AND PROBLEMS. U.S. Dept. Agr., Econ. Res. Serv., ERS–151, 30 pp. March 1964.

Whether the Desert Land Act of 1877 is operational for the future is a critical question in the minds of 20th century legislators. This report sets forth some of the recent events and conditions that need to be considered if the act and the present machinery for administering it are to be revised.

Thompson, John W. A GUIDE TO LOWER COSTS AND GREATER EFFICIENCY IN CURING CATTLE HIDES. U.S. Dept. Agr., Agr. Econ. Rpt. 54, 20 pp. May 1964.

Agitated brine curing of hides can mean appreciable savings for processors. The report describes costs for two model plants, one using the conventional pack-salt curing method for processing a minimum of 500 hides daily, the other using agitated brine for processing and fleshing a daily minimum of 1,000 hides. The agitated brine method saved 5 cents a hide, even though fleshing was included in the costs.

Vosloh, Carl J., Jr. OPERATING COSTS IN PACKING MIXED FEEDS WITH EMPHASIS ON LABOR AND CAPITAL. U.S. Dept. Agr., Mktg. Res. Rpt. 658, 20 pp. May 1964.

Packaging costs in the mixed feeds industry will tend to rise with declining demand for packaged feeds, due to growing trend in bulk feed usage. The report analyzes

packaging costs for two sizes of mixed feed plants packing 65 tons and 160 tons per 8-hour shift. Study models of these sizes were developed from records kept by feed plants in 35 States.

Webster, Henry H. Timber Management and Economic Analysis: A Case Study. U.S. Dept. Agr., Forest Serv. Res. Paper NE–14, 26 pp. 1963.

An economic analysis of timber-production possibilities in Elk State Forest in north central Pennsylvania. Analysis proved efficient for ranking management opportunities and for setting priorities within a given budget, but proved of little use in determining how large the budget should be.

Wesson, William T. Taxes Paid by Firms Marketing Farm Food Products. U.S. Dept. Agr., Agr. Econ. Rpt. 50, 52 pp. February 1964.

The report measures the amount of Federal income tax and business taxes paid by both corporate and noncorporate food processors, wholesalers, and retailers during 1947–60. The data are adjusted to reflect taxes paid on food originating on U.S. farms only. Analyses are made to show the relation between size of firms and taxes paid per dollar of sales. Methodology used to estimate taxes for noncorporate firms, adjustments of the data, and related material are included in an appendix.

Wilmot, Charles A., and David M. Alberson. Increasing the Efficiency of Power Used for Materials Handling in Southwestern Cotton Gins. U.S. Dept. Agr., Econ. Res. Serv., ERS–154, 18 pp. March 1964.

This report indicates that substantial savings in operating costs could be realized in most cotton ginning operations by peaking efficiency of individual air systems used for materials handling and by rearranging gin machinery to eliminate unnecessary fans, motors, and piping.

Wright, Bruce H. For-Hire Trucking of Exempt Farm Products: Operating Practices and Nature of Competition. U.S. Dept. Agr., Mktg. Res. Rpt. 649, 38 pp. March 1964.

During 1962, 137 interstate for-hire truckers of agricultural commodities not subject to Interstate Commerce Commission economic regulations were asked about sources of business, principal competition, methods of establishing rates, operating costs, trip-leasing, and equipment used. Fifty-six percent of them named other truckers in the same business as among their chief competitors. Railroads were mentioned as important competitors by 12 percent, private truckers by 10 percent, and ICC-regulated trucks by 8 percent.

U.S. Department of Agriculture. Agricultural Policies of Foreign Governments, Including Trade Policies Affecting Agriculture. U.S. Dept. Agr., Agr. Handbook 132, 266 pp. Revised March 1964.

This new report updates a 1957 study of agricultural policies of foreign governments. It deals with some of the economic changes in foreign countries from 1957 to 1963, the new regional economic integration movements in Latin America, Europe, Africa, and Asia, and adds to the list of countries surveyed the newly independent countries which have emerged in the past 5 years.

U.S. Department of Agriculture. The 1964 Western Hemisphere Agricultural Situation. Suppl. 1 to The 1964 World Agricultural Situation. Econ. Res. Serv., ERS-Foreign 71, 63 pp. February 1964.

Increased agricultural production expected in the Western Hemisphere in 1963–64 will result in larger supplies for consumption and trade. The region should continue as the world's major agricultural supplier with exports of most agricultural commodities approaching record levels in 1964.

U.S. Department of Agriculture. The 1964 Western Europe Agricultural Situation. Suppl. 2 to The 1964 World Agricultural Situation. Econ. Res. Serv., ERS-Foreign-72, 85 pp. February 1964.

Western Europe continues as the region having the highest growth rate in the free world. Growth in the gross domestic product in the European Economic Community during 1964 may approximate 4 to 4.5 percent in real terms. Economic activity is expanding in the United Kingdom and Spain and continuing at a high level in most other European countries.

U.S. Department of Agriculture. The 1964 Eastern Europe Agricultural Situation. Suppl. 3 to The 1964 World Agricultural Situation. Econ. Res. Serv., ERS-Foreign-73, 62 pp. March 1964.

The most significant feature of the agricultural situation in Eastern Europe during 1963 was the very poor grain crop in the Soviet Union. This, coupled with mediocre crops in most of Eastern Europe, resulted in a decline in total agricultural output in the area.

U.S. Department of Agriculture. The 1964 Far East, Communist China, Oceania Agricultural Situation. Suppl. No. 4 to The 1964 World Agricultural Situation. Econ. Res. Serv., ERS-Foreign-74, 57 pp. March 1964.

The economies of most countries in the Far East continued to move ahead in 1963. Industrial output showed significant, although generally moderate, gains in almost all countries. In contrast, agriculture, which continues as the dominant force in the economies of most countries of the region, was practically stagnant.

U.S. Department of Agriculture. The 1964 Africa and West Asia Agricultural Situation. Suppl. 5 to The 1964 World Agricultural Situation. Econ. Res. Serv., ERS-Foreign-75, 81 pp. March 1964.

Agricultural production in West Asia last year rose 5 percent above the 1962 level and was 37 percent above the 1952–54 base period average. For the area as a whole, however, per capita farm production has not made rapid gains and is only 5 percent over the 1952–54 base period.

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